Developing a Geomatics Protocol for Urban Air Pollution Sampling Based on a Range of Input Data

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The first part of this research is to conduct a spatial search for locating six passive air pollution samplers in the Great Vancouver Regional District (GVRD) in the Fall of 2004, targeting woodsmoke emissions. During the winter months woodsmoke provides a significant amount of ambient particles in regions like Vancouver and is associated with a range of acute and chronic respiratory effects, especially among children. These samplers and those of the subsequent full campaign will trace woodsmoke via the woodsmoke tracer levoglucosan. A range of data have been used in this spatial search. Woodburning consumer surveys were conducted by regional and provincial agencies and enhanced by property assessment data showing woodburning appliances. Inverse distance weighting was used to create a continuous surface over the study region. This was refined with digital elevation models, a model of air pollution accumulation over the 3-dimensional landscape (or compound topographic index - CTI) and wind speed-directional data (compound wind index - CWI). A spatial sampling protocol was applied where each of these factors, plus population density, were equally weighted. Hot, intermediate and cool spots were identified and samplers located.

The second part of this analysis is to find optimized mobile monitoring routes for travel between and around fixed-site samplers. Initial design included two routes: One located in the northern part of the GVRD including three fixed sampler stations – Downtown Core, North Vancouver and Pitt Meadows, and a second one located in the southern part of the GVRD including South Burnaby, Southwest Surrey and White Rock. Each route was designed to start from UBC, travel to three fixed samplers, circle once or twice around each sampler, then travel back to UBC. The total time spent on each route was to be approximately four hours starting from 9 pm and ending at 1 am.

Standard road network analysis is usually used to minimize the distance/time traveled. However, our analysis aims to maximize regional exposure variation, and if possible the regional variation of elevation along the mobile routes. We tried to capture both PM 2.5 hot and cool spots, high and low elevations, or high and low population densities on our route tracing. Weighting functions were used to define values of "cost" associated with travel on road segments including PM 2.5, elevation, population density and their interactions. These weighting functions were applied in a Geodatabase Network Analysis in ArcGIS 9.0 and resultant routes were compared with results using only road type and travel time as weight.

Woodsmoke tracer recordings combined with mobile nephelometer sampling were compared with enhanced woodsmoke surface. The enhanced surface was confirmed to be a good prediction of spatial distribution of PM 2.5 over the region ($p<0.01$ and adj. $R^2 = 0.31$ of 10 measurements) and held a strong potential for further exposure analysis.